
Towards the Design of a Virtual Heritage Experience based on the World-as-Support Interaction Paradigm

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CHI'17 Extended Abstracts, May 06-11, 2017, Denver, CO, USA
ACM 978-1-4503-4656-6/17/05.
<http://dx.doi.org/10.1145/3027063.3053089>

Abstract

We present the initial design stage of a Virtual Heritage experience for a bomb shelter built during the Spanish Civil War, namely *Refugi 307*. The shelter currently belongs to the History Museum of Barcelona which provides guided tours through the cultural heritage site for schools and the general public. The aim of the study was to define the requirements for the design of a first prototype based on the *World-as-Support* interaction paradigm. We conducted an ethnographic study and Participatory Design workshop to analyze different aspects of the requirements and to include multiple needs and viewpoints of the involved stakeholders. Based on the outcomes, we outline the potential for activities to foster (1) *contextual-awareness* between the learning content and the cultural heritage site, (2) *environment-awareness* in relation to missing objects in the physical space and (3) *social-awareness* to embody feelings related to solidarity and empathy.

Author Keywords

Augmented Reality; Virtual Heritage; World-as-Support; Learning; Participatory Design; Children.

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; Interaction styles.

Introduction

Cultural heritage sites play a crucial role in how people understand history and culture. According to Betsworth et al. [2], they have “*the potential to teach us important lessons, such as where we came from and subsequently, the people it has made us today*”. Interactive experiences for these contexts are commonly used to complement learning concepts rather than being considered as independent learning tools [5,16,17]. To achieve this, a wide range of screen-based technology approaches have been explored in museums [19] and cultural heritage (CH) sites [20,21,23]. The interaction with multimedia content allows visitors to obtain a better understanding, e.g. of people living in past cultures [12]. Through virtual and augmented reality, hidden experiences or vanished aspects of the site are highlighted [11,18].

However, technologies which support screen-based interfaces, such as smartphones or tablets, tend to draw user attention away from the physical space onto a framed window which tends to isolate and provide an individual experience. Hence, the employed technology can become a distraction or even the main focus of the visit. In this context, Müller et al. [15] analyzed users’ behavior in a collaborative task with a tablet-based AR application. The authors pointed out that almost no participants paid attention to the physical environment during the experience. Betsworth et al. [2] described how, in the act of holding the screen-based device in front of the physical world, the system became a “digital divider”. In other words, when using screen-based devices (e.g. in museums) visitors perceive the world which surrounds them and the displayed multimedia content through a “digital window”. Consequently, the user’s focus may shift from the

interest and interaction with the physical environment and other visitors to an isolated screen-based experience. On the other hand, the design of interactive experiences for non-standard museum spaces [23], such as archaeological sites, is particularly challenging. These site-specific spaces often cannot be modified by adding physical objects or installations. Therefore, they acquire their importance and meaning through their situatedness; i.e. the meaning of their historical context is provided by the fact that the visitor is actually physically present on site. Such visits are often complemented by guided tours to direct visitors’ attention towards aspects that are not necessarily obvious without further explanations. Furthermore, recent research has addressed these challenges by exploring the potential of interactive guides based on audio and tactile feedback [7,8,10,22]. Nevertheless, visitors still need to imagine missing artifacts, people living during that period, or related events. Due to limited knowledge and the lack of previous experiences, it may be particularly difficult for children to imagine some of these contents and situations.

To address these challenges, we present the design process of a preliminary prototype using an emerging interaction design paradigm, named the *World-as-Support (WaS)* [14], in the context of a site-specific learning experience for a CH site. This paradigm is based on projective AR; i.e. augmentation is achieved by projecting the digital content on the physical world surrounding the user via a handheld device. This portable system based on a pico-projector and a mobile device dynamically recognizes the surrounding physical world (i.e. topography, objects, users, and motion) and projects the context-aware digital information directly onto it [1]. This allows interaction designers to take



Figure 1: A school class visiting the guided tour of the cultural heritage site Refugi 307.



Figure 2: During the KidReporter technique children expressed their interests towards certain places in the shelter.

advantage of the benefits of Reality-Based Interaction, such as environment awareness and social awareness [9]. Moreover, as users act within the physical world to interact with digital content [4], it affords the potential of bodily and tangible interaction such as tangible manipulation, spatial interaction and embodied facilitation [6].

We now explain the initial design stage of a Virtual Heritage (VH) experience for a non-standard museum space. The aim of our study was to define the requirements for the design of a first prototype based on the WaS interaction paradigm. We conducted an ethnographic study and Participatory Design (PD) workshop to analyze the requirements and to include the needs and viewpoints of the involved stakeholders, namely: 5th and 6th-grade children, museum and education experts, and guides. Based on the outcomes, we then define and describe the specific educational goals for the augmented, full-body interactive, non-formal learning experience that complements the guided tour.

Designing the VH experience

Our study was carried out in the context of a CH location, namely Refugi 307. The site is one of the 1,402 bomb shelters that were built by civilians during the Spanish Civil War in Barcelona aimed at protecting the population. The shelter is nowadays part of the History Museum of the city which provides guided tours through the cultural heritage site to schools and the general public. It consists of an almost empty and twisting tunnel 200 meters long (Figure 1). Visitors can get an impression of the living conditions during the Spanish Civil War and some facilities inside such as benches, an infirmary, a children's room, and a

fireplace. The walls and ceiling of the shelter show traces of objects from the past (e.g. the original lighting system, signs with instructions on behavior rules, holes to fix stretchers to the wall, etc.) that were once installed inside. Poor light conditions and high humidity in the shelter limit the possibilities to permanently install multimedia systems in the physical space.

In order to gather requirements from the different stakeholders, we carried out (1) three project meetings with two museum and education experts, (2) interviews with three tour guides and four teachers from three different local schools that visited the Refugi 307 with their class, (3) guided tours with two school classes and (4) two PD sessions with each of them.

Procedure of PD Workshop

In the study participated a total of 40 children (girls = 18; boys = 22; age mean = 10.78 years old). The first session lasted for 120 minutes (90 minutes guided tour in the shelter and 30 minutes PD activities). After the visit to the shelter, we divided the children into groups of 3-4 members and instructed them in an activity based on the KidReporter technique [28]. Each group was asked to record a 2-minute video on the place in the shelter they found most interesting (Figure 2). Therefore, we handed out a map of the shelter and gave each group 10 minutes to choose one place of interest and to brainstorm how they would perform the interview.

The second session held in the school lasted for 180 minutes. The children were again divided into the same groups. Using the maps of the shelter, they were asked to indicate and explain the places that they



Figure 3: Children indicated on maps of the shelter the aspects which they remembered and had caught their attention during the guided tour.



Figure 4: Children made storyboards about events during the Spanish Civil War.



Figure 5: Children presented their ideas for the improvements for the guided tour using a low-tech prototype.

remembered and that had caught their attention the most (Figure 3). The children wrote their comments on post-it notes and placed them on the map. We interviewed each group individually during the activity.

After that, each child received a different storyboard template. The first scene was already filled out with a drawing made by children during the Spanish Civil War (Figure 4). They were encouraged to think of a narrative related to the presented drawing. The aim of this activity was to evaluate children's interests and personal values in relation to the learning topic.

Subsequently, the children were instructed to re-design the guided tour according to their own interests and preferences. We first explained our interactive technology approach to them (the WaS paradigm) based on pico-projectors to augment the physical space with projected digital content. The children were then asked to produce low-tech prototypes we called "spotlights"; i.e. the children drew on transparent plastic and placed them over one end of a paper roll which had a flashlight inside (Figure 5). This simulated the projection capabilities of the final handheld device. Finally, each group gave a 5-minute presentation to explain and enact their ideas with the low-tech prototype. During all PD activities, we recorded short video interviews with each group while they were working on their proposals. The aim was to capture their different ideas and reflections during the design process.

Analysis

During the activities, two researchers took notes and all interviews and sessions were video recorded. Subsequently, the video was transcribed using a

descriptive format focusing on experts and children's verbal expressions and behavior. The analysis was carried out through a grounded approach [3]. The goals of the analysis were to identify (1) experts' educational goals and (2) children's interests, understanding, core meanings and misconceptions related to the learning topic. From the data collected, key points were marked and coded and then extracted from the text. The codes were grouped into similar concepts and final categories were formed. Two researchers performed the analysis. After a process of individual coding, a common agreement was reached through a number of meetings.

Results

Educational Goals: The findings from the interviews with educational experts from the museum and school determined that one of the main goals of the interactive experience should be to foster children's competence in understanding the relation between historical events from the Spanish Civil War and similar contemporary conflicts occurring today (e.g. the civil war in Syria). This aim involved strengthening the feeling of solidarity and empathy with people who have suffered and/or are still suffering war. To offer children emotional anchors to the learning topic, the content of the experience had to link to situations they can relate to their own identity; e.g. family members from previous generations or children in war zones in other countries.

Children's Interest and Understanding: The results of the ethnographic study indicated that the children were very engaged during the guided tour. They asked many questions about details of the explained content.

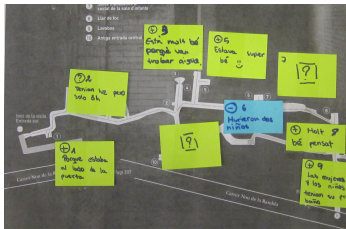


Figure 6: This group was particularly interested in the water fountain and the power generator. The children expressed their sadness about the accident in the children's room. They also expressed curiosity towards parts of the shelter that were not included in the guided tour.

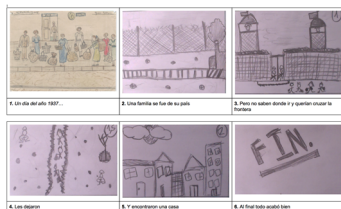


Figure 7: A child explained in her story how a family had to leave their home and finally found a "happy" life in another country.

Some children got very excited about being in the shelter. Other children felt uncomfortable due to physical conditions of the shelter (e.g. darkness, low temperature, or humidity). During the visit, they had many opportunities to "embody" past events; e.g. while sitting on benches just like civilians did during bomb attacks eighty years back.

During the Kidreporter activity, 6 out of 10 groups chose to perform the interview on the *infirmary*. They focused on the fact that it was located in the middle of the tunnel and hence the safest place in the shelter. They expressed the importance to have a place where injured people could be treated. Three groups performed an interview on the *fire place*. They found it interesting first because the place has a chimney and ventilation system built into the stone of the mountain under which the shelter was built. Second, despite the harsh conditions in the shelter, a family from the South of Spain lived in it for ten years during the post-war period. Third, a man used the shelter to illegally grow mushrooms on the walls. Only one group performed an interview on the *children's room*. They expressed their sadness about the collapse of the ceiling during a bombing attack which injured two children. These findings suggest the children were particularly interested in content related to values such as safety, caring for each other, family and personal fate.

During the map activity (Figure 6) in class, in addition to the previously presented places, all ten groups reported on at least one other location related to people's basic needs: toilets (9 out of 2 groups), a water fountain (8 groups), and a power generator for the lighting system (3 groups). Also, one group mentioned that they were interested to see the original

signs on behavior rules; another group asked for images of bombs and shrapnel; and two groups expressed their curiosity about tunnel segments that were not included in the guided tour. The results of this activity revealed that the children showed a high interest in civilian's living conditions in the shelter. Furthermore, they point towards the need of visualizing missing and hidden artifacts in the physical space.

The storyboard activity helped us to get deeper insights on children's cultural values. For instance, the children reported on the harsh living conditions during the war. Four children wrote their stories about the lack of food and how people had to find provisions to survive. One child wrote about men who went to the frontlines. Another child mentioned that people had lost their houses. Two children explained how people were forced to leave their country. However, many of these stories had a "happy end", i.e. as soon as the war ended everything went back to "normal" (Figure 7). Hence, the results indicate that the children were not conscious about long-term effects caused by the war.

Children's main misconceptions across the different activities were related to the expectations of finding weapons in the shelter from people who tried to protect their family against Dictator Franco's army (6 children). In other words, they did not understand that the shelter represented a "passive" form of defense, in contrast to the "active" defense that involved using weapons.

Ideas for improvements of guided tour: The children proposed, e.g. (1) a treasure hunt activity with hints to provide a playful experience during the guided tour, (2) to explain the guided tour through pictures, (3) an activity where children could dig up the destroyed

children's room and discover what was hidden under the stones, (4) to perform a drill of the bomb alarm and experience the rushing of people into the shelter. Thus, children's proposals revealed a need for participative and hands-on activities during the guided tour.

Requirements for the prototype

Our approach helped us to define key requirements for the design of a full-body interactive VH learning experience for this CH site. Our observations confirmed that the guided tour had already a high educational potential in introducing the learning topic to the children. However, we saw several opportunities to complement it through a VH experience based on the WaS interaction paradigm. We suggest employing the novel paradigm by taking advantage of children's situatedness and combining this experience with the augmentation of "invisible" aspects of the environment. On the other hand, the promotion of specific interactions in the physical space could support children's meaning making process of the learning contents. Thus, we propose to integrate the following types of activities into the learning experience during the guided tour.

- *Context-aware AR activities* through location-based projections of audiovisual material on historical events (e.g. a testimonial of a woman who volunteered as a nurse can only be projected in the infirmary). Having multiple location-based events allows presenting content from different perspectives and comparing them. These activities could help children to understand changes in society, different standpoints upon historical events (e.g. active vs. passive defense), and long-term effects of the civil war (e.g. collective trauma).

- *Environment-aware AR activities* through projections based on surface and object recognition to represent missing content at their original locations (e.g. the signs of behavior rules can be projected on the empty holes on the walls). These activities may facilitate children to imagine objects they have never been in contact with.
- *Social-aware AR activities* through projections of multiple pieces of content and a common task (e.g. two children project one piece each of a larger image that together represents a stretcher. They must move their images in a synchronized way to bring an injured person safely to the infirmary). By performing similar actions to those performed by civilians during the war, children could perceive, for example, the notion of physical effort [13]. These activities could help children to understand feelings of solidarity and empathy of people in these situations.

Conclusions

In this paper, we have described the initial design stage aimed at gathering requirements for a full-body interactive VH learning experience. The results allowed us to formulate concrete activities that were recently implemented in a first mid-tech prototype based on the WaS interaction paradigm. We are currently exploring its potential and limitations in the contexts of cultural heritage sites and other learning contexts [14]. From a broader perspective, we also see potentials for the application of this paradigm in other areas that benefit from merging on-site AR and embodied interaction.

Acknowledgements

Supported by the Spanish Ministry of Economy and Competitiveness (Grant TIN2014-60599-P).

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